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A one year post-fire biogeochemical cycling record of a sandstone mountain fynbos ecosystem, South Africa

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The Cape Floristic Region (CFR) in southwestern South Africa is a Mediterranean-type ecosystem dominated by highly diverse and endemic fynbos vegetation. In this study, the chemistry of rainwater (total wet and dry deposition), stream water and soil saturated paste extracts of the sandstone fynbos biome of the Kogelberg Biosphere Reserve reveals how the cycling of Cl, Na, $SO_{4,}$Mg, Ca and K varied over a one year period following a major fire event. Fire is a critical component of fynbos ecology, but the fynbos ecosystem is under threat as the fire return frequency increases as a result of human activities. The underlying bedrock geology of the sandstone fynbos biome is dominated by quartz-rich (>97 wt% SiO_2) sandstone providing few nutrients to the overlying thin (2 to 20 cm), acidic soils. Additional sources of nutrients to the ecosystem are derived from windblown marine and dust (consisting of minerals, organic matter and fire ash) aerosols. Rainout of marine aerosols decreases away from the coast. The delivery of marine aerosols (Cl, Na, $SO_4$and Mg) corresponds with summer southerly winds from the ocean and windblown dust ($SO_{4,}$Mg, Ca and K) is delivered through winter northerly winds from the continental interior. Remineralization of organic matter, dissolution of fire ash and chemical weathering of clay minerals derived from the bedrock and from windblown minerals provide additional sources of nutrients to the vegetation. Salts accumulated within and on top of soil surfaces during the dry summer period are washed into streams during the wet winter months. Afromontane forests occur within deep rocky ravines cut by mountain streams and are protected from fire. The afromontane vegetation did not burn during the fire and benefited from the release of nutrients but regrowth of fynbos on open burnt slopes was slow and most of the released nutrients were lost via streams. Fynbos regrowth largely reflected the hydrology of the study area and corresponded to the pre-fire distribution of biomass with relatively low biomass on mountain ridges and slopes in comparison to lower slopes and valley floors, particularly along stream banks. The removal of above ground plant biomass increased streamflow from the reduction in transpiration and rainfall interception by plants. Hydrophobicity in soils increased following the fire leading to partially burnt organic plant debris being washed down slope to accumulate on the lower slopes and stream valley floors. The geochemical results of this study provide insights on the climate-hydrology-soil interactions of the fynbos ecosystem and its unusually rich biodiversity. The resetting of the ecosystem every 20 to 40 years by fire and the interaction between atmospheric processes and hydrology likely enhances its long term survival.